E-series™ Routing Platforms

E320 Module Guide

Release 8.1.x

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This guide provides an overview and description of the line modules (LMs), switch route processor (SRP) modules, switch fabric modules (SFMs), and input/output adapters (IOAs) available for the E320 router.

NOTE: A release may support multiple versions of a module or IOA. For information, see *Software Compatibility* in *JUNOSe System Basics Configuration Guide, Chapter 6, Managing Modules*.

Table 1 on page 3 lists the modules and IOAs supported by the router.

This book also contains the following appendixes:

- IOA Protocol Support on page 45
- Slot Combinations on page 63
- Module Name Cross-Reference Information on page 65
- Product Reclamation and Recycling Program on page 67

For more information about E320 routers, modules, and IOAs, refer to the following books:

- Module installation and maintenance—*E320 Hardware Guide*
- Managing E320 routers—*JUNOSe System Basics Configuration Guide*
- Configuring E320 modules—*JUNOSe Link Layer Configuration Guide*

Table 1: E320 Modules and IOAs

Module/IOA Type	Module Label	First JUNOSe Support	Page
Line Module			
LM-4	ES2 4G LM	7.0.1	5
LM-10 Uplink	ES2 10G UPLINK LM	7.2.0	7
LM-10	ES2 10G LM	8.0.0	9
SRP Module			
SRP-100	SRP-100	7.0.1	11
SRP-320	SRP-320	7.3.0	13
SFM Module			
SFM-100	SFM-100	7.0.1	15
SFM-320	SFM-320	7.3.0	16
Gigabit Ethernet IOA			
GE-4 IOA	ES2-S1 GE-4 IOA	7.0.1	18
GE-8 IOA	ES2-S1 GE-8 IOA	7.2.0	22
10GE IOA	ES2-S1 10GE IOA	7.0.1	26
10GE PR IOA	ES2-S2 10GE PR IOA	7.2.0	29
OC3/STM1 ATM IOA			
OC3/STM1-8 ATM IOA	ES2-S1 OC3-8 STM1 ATM IOA	7.0.1	33
OC12/STM4 ATM IOA			
OC12/STM4-2 ATM IOA	ES2-S1 OC12-2 STM4 ATM IOA	7.0.1	35

Table 1: E320 Modules and IOAs *(continued)*

Module/IOA Type	Module Label	First JUNOSe Support	Page
OC12/STM4 POS IOA			
OC12/STM4-2 POS IOA	ES2-S1 OC12-2 STM4 POS IOA	7.0.1	37
OC48/STM16 IOA			
OC48/STM16 POS IOA	ES2-S1 OC48 STM16 POS IOA	7.0.1	40
Redundancy IOA			
REDUND IOA	ES2-S1 REDUND IOA	7.0.1	42
Service IOA			
SERVICE IOA	ES2-S1 SERVICE IOA	7.0.1	43
SRP IOA			
SRP IOA	SRP IOA	7.0.1	44

LM-4 Line Module

Module label	ES2 4G LM
Number of ports	■ Not applicable
Software release	■ First supported: 7.0.1
Description	■ 200 W ■ Acts as frame forwarding engines for the physical interfaces ■ Responsible for processing data traffic ■ Pairs with IOAs to process data from different types of network connections
Capability	■ Supports a line rate of 128–byte packets on IOAs ■ The 100–Gbps switch fabric allocates 3.4 Gbps of overall bandwidth to each regular line module slot and 10 Gbps of overall bandwidth to each of the turbo slots (slot 2 and slot 4). ■ The 320–Gbps switch fabric allocates 10 Gbps of overall bandwidth to each line module slot. ■ See *JUNOSe System Basics Configuration Guide, Chapter 6, Managing Modules* for more information.
Software features	■ Not applicable
Line module compatibility	■ Not applicable
SRP module compatibility	■ SRP-100 ■ SRP-320
Line module redundancy compatibility	■ Yes (Redundancy IOA must be installed in either slot 0 or slot 11) ■ Can only backup another ES2 4G LM
Port redundancy support	■ Not applicable
Cables and connectors	■ Not applicable
LEDs	When lit, LED indicates: ■ OK (green)—Self-test passed ■ FAIL (red)—Failure detected ■ ONLINE (green)—Online with no alarms or errors ■ REDUN (green)—Redundant card available

Alarms, errors, and events	■ See *Monitoring Modules* in *JUNOSe System Basics Configuration Guide, Chapter 6, Managing Modules*.

LM-10 Uplink Line Module

Module label	ES2 10G UPLINK LM
Number of ports	■ Not applicable
Software release	■ First supported: 7.2.0

Description	■ 150 W
	■ Acts as frame forwarding engines for the physical interfaces
	■ Processes up to 10 Gb of data traffic
	■ Pairs with ES2–S2 10GE PR IOA only
	■ In a SRP-100 configuration, it must be installed in a turbo slot only (slot 2 or slot 4)
	  ■ If you install the line module in a slot other than slot 2 or slot 4, it will be disabled
	  ■ If you install a LM-10 Uplink module next to a configured line module that is already installed in slot 3 or slot 5, the LM-10 Uplink module will be disabled
	  ■ If you install a line module in slot 3 or slot 5 next to a previously installed LM-10 Uplink module, the non-LM-10 Uplink module will be disabled
	■ In a SRP-320 configuration, it can be installed in any slot

Capability	■ Supports a line rate of 128–byte frames on IOAs ■ The 100–Gbps switch fabric allocates 3.4 Gbps of overall bandwidth to each regular line module slot and 10 Gbps of overall bandwidth to each of the turbo slots (slot 2 and slot 4). ■ The 320–Gbps switch fabric allocates 10 Gbps of overall bandwidth to each line module slot. ■ See *JUNOSe System Basics Configuration Guide, Chapter 6, Managing Modules* for more information.
Software features	■ Not applicable
Line module compatibility	■ Not applicable
SRP module compatibility	■ SRP-100 ■ SRP-320
Line module redundancy compatibility	■ Yes (Redundancy IOA must be installed in either slot 0 or slot 11) ■ Can only backup another ES2 10G UPLINK LM
Port redundancy support	■ Not applicable
Cables and connectors	■ Not applicable

LEDs	When lit, LED indicates: ■ OK (green)—Self-test passed ■ FAIL (red)—Failure detected ■ ONLINE (green)—Online with no alarms or errors ■ REDUN (green)—Redundant card available
Alarms, errors, and events	■ See *Monitoring Modules* in *JUNOSe System Basics Configuration Guide, Chapter 6, Managing Modules*.

LM-10 Line Module

Module label	ES2 10G LM
Number of ports	■ Not applicable
Software release	■ First supported: 8.0.0

Description	■ 215 W
	■ Acts as frame forwarding engines for the physical interfaces
	■ Processes up to 10 Gb of data traffic
	■ Pairs with ES2–S2 10GE PR IOA and ES2–S1 GE-8 IOA
	■ In a SRP-100 configuration, it must be installed in a turbo slot only (slot 2 or slot 4)
	  ■ If you install the line module in a slot other than slot 2 or slot 4, it will be disabled
	  ■ If you install the LM-10 module next to a configured line module that is already installed in slot 3 or slot 5, the LM-10 module will be disabled
	  ■ If you install a line module in slot 3 or slot 5 next to a previously installed LM-10 module, the non-LM-10 module will be disabled
	■ In a SRP-320 configuration, it can be installed in any slot

Capability	■ Supports a line rate of 128–byte frames on IOAs ■ The 100–Gbps switch fabric allocates 3.4 Gbps of overall bandwidth to each regular line module slot and 10 Gbps of overall bandwidth to each of the turbo slots (slot 2 and slot 4). ■ The 320–Gbps switch fabric allocates 10 Gbps of overall bandwidth to each line module slot. ■ See *JUNOSe System Basics Configuration Guide, Chapter 6, Managing Modules* for more information.
Software features	■ Not applicable
Line module compatibility	■ Not applicable
SRP module compatibility	■ SRP-100 ■ SRP-320
Line module redundancy compatibility	■ Yes (Redundancy IOA must be installed in either slot 0 or slot 11) ■ Can only backup another ES2 10G LM
Port redundancy support	■ Not applicable
Cables and connectors	■ Not applicable

LEDs	When lit, LED indicates: ■ OK (green)—Self-test passed ■ FAIL (red)—Failure detected ■ ONLINE (green)—Online with no alarms or errors ■ REDUN (green)—Redundant card available
Alarms, errors, and events	■ See *Monitoring Modules* in *JUNOSe System Basics Configuration Guide, Chapter 6, Managing Modules*.

SRP-100 Module

Module label	SRP-100
IOA label	SRP IOA
Number of IOA ports	■ Not applicable
Software release	■ First supported: 7.0.1
Description	■ 75 W ■ Switch route processor (100 Gbps) ■ Performs system management, route table calculations and maintenance, forwarding table computations, statistics processing, configuration storage, and other control plane functions ■ Has 2 GB of memory ■ Works with the SFM–100 module to create a switch fabric ■ Uses a PCMCIA nonvolatile storage (NVS) card to store the system's software and configuration files ■ Must be installed only with SRP-100 module and SFM–100 modules
Capability	■ Not applicable
Software features	■ Not applicable
Line module compatibility	■ ES2 4G LM ■ ES2 10G UPLINK LM
SRP module compatibility	■ Cannot use with SRP-320 module or SFM-320 module
Module redundancy support	■ 1:1 redundancy
Port redundancy support	■ Not applicable
Cables and connectors	■ Not applicable

LEDs	Board-level LEDs: ■ OK (green)—Self-test passed ■ FAIL (red)—Failure detected ■ ONLINE (green)—Online with no alarms or errors ■ REDUN (green)—Module is the spare system controller, is up, and is ready to take the role of the online system controller. When LED is not lit, module is not acting as the spare system controller. ■ PA (green)—Power source on source A ■ PB (green)—Power source on source B ■ FO (green)—Fan OK ■ FF (red)—Fan failure ■ LK (green)—Ethernet link up ■ AC (green)—Blinks when there is Ethernet activity (traffic) on link Flash Card Port LEDs: ■ 0 (green)—When lit, indicates slot is busy ■ 1 (green)—When lit, indicates slot is busy
Alarms, errors, and events	■ See *Monitoring Modules* in *JUNOSe System Basics Configuration Guide, Chapter 6, Managing Modules*.

SRP-320 Module

Module label	SRP-320
IOA label	SRP IOA
Number of IOA ports	■ Not applicable
Software release	■ First supported: 7.3.0

Description	■ 140 W
	■ Switch route processor (320 Gbps)
	■ Performs system management, route table calculations and maintenance, forwarding table computations, statistics processing, configuration storage, and other control plane functions
	■ Has 4 GB of memory
	■ Works with the SFM–320 module to create a switch fabric
	  ■ The 320–Gbps fabric allocates 10 Gbps of overall bandwidth to each line module slot.
	■ Uses an ATA flash card to store the system's software and configuration files
	  ■ Two flash cards are required for operation
	■ Must be installed only with SRP-320 module and SFM–320 modules

Capability	■ Not applicable
Software features	■ Not applicable
Line module compatibility	■ ES2 4G LM ■ ES2 10G UPLINK LM
SRP module compatibility	■ Cannot use with SRP-100 module or SFM-100 module
Module redundancy support	■ 1:1 redundancy
Port redundancy support	■ Not applicable
Cables and connectors	■ Not applicable

LEDs	Board-level LEDs: ■ OK (green)—Self-test passed ■ FAIL (red)—Failure detected ■ ONLINE (green)—Online with no alarms or errors ■ REDUN (green)—Module is the spare system controller, is up, and is ready to take the role of the online system controller. When LED is not lit, module is not acting as the spare system controller. ■ PA (green)—Power source on source A ■ PB (green)—Power source on source B ■ FO (green)—Fan OK ■ FF (red)—Fan failure ■ LK (green)—Ethernet link up ■ AC (green)—Blinks when there is Ethernet activity (traffic) on link Flash Card Port LEDs: ■ 0 (green)—When lit, indicates slot is busy ■ 1 (green)—When lit, indicates slot is busy
Alarms, errors, and events	■ See *Monitoring Modules* in *JUNOSe System Basics Configuration Guide, Chapter 6, Managing Modules*.

SFM-100 Module

Module label	SFM-100
IOA label	■ Not applicable
Number of IOA ports	■ Not applicable
Software release	■ First supported: 7.0.1
Description	■ 40 W ■ Switch fabric module (100 Gbps) ■ Works with the SRP-100 module to create a switch fabric ■ Must be installed only with SRP-100 module and SFM–100 modules
Capability	■ Not applicable
Software features	■ Not applicable
Line module compatibility	■ ES2 4G LM ■ ES2 10G UPLINK LM
SRP module compatibility	■ SRP-100 ■ Cannot use with SRP-320 module or SFM-320 module
Module redundancy support	■ N + 1 redundancy
Port redundancy support	■ Not applicable
Cables and connectors	■ Not applicable
LEDs	When lit, LED indicates: ■ OK (green)—Self-test passed ■ FAIL (red)—Failure detected ■ ONLINE (green)—Online with no alarms or errors ■ REDUN (green)—N + 1 redundancy is enabled; 2 SRPs and 3 SFMs must be installed and working. When LED is unlit, one of the five fabric slices is down or not installed; N + 1 redundancy is not enabled. **NOTE:** When REDUN LED is on, the module may be removed without interrupting service.
Alarms, errors, and events	■ See *Monitoring Modules* in *JUNOSe System Basics Configuration Guide, Chapter 6, Managing Modules*.

SFM-320 Module

Module label	SFM-320
IOA label	■ Not applicable
Number of IOA ports	■ Not applicable
Software release	■ First supported: 7.3.0
Description	■ 95 W ■ Switch fabric module (320 Gbps) ■ Works with the SRP-320 module to create a switch fabric ■ The 320–Gbps fabric allocates 10 Gbps of overall bandwidth to each line module slot. ■ Must be installed only with SRP-320 module and SFM–320 modules
Capability	■ Not applicable
Software features	■ Not applicable
Line module compatibility	■ ES2 4G LM ■ ES2 10G UPLINK LM
SRP module compatibility	■ SRP-320 ■ Cannot use with SRP-100 module or SFM-100 module
Module redundancy support	■ N + 1 redundancy
Port redundancy support	■ Not applicable
Cables and connectors	■ Not applicable
LEDs	When lit, LED indicates: ■ OK (green)—Self-test passed ■ FAIL (red)—Failure detected ■ ONLINE (green)—Online with no alarms or errors ■ REDUN (green)—N + 1 redundancy is enabled; 2 SRPs and 3 SFMs must be installed and working. When LED is unlit, one of the five fabric slices is down or not installed; N + 1 redundancy is not enabled. **NOTE:** When REDUN LED is on, the module may be removed without interrupting service.

Alarms, errors, and events

- See *Monitoring Modules* in *JUNOSe System Basics Configuration Guide, Chapter 6, Managing Modules*.

GE-4 IOA

IOA label	ES2-S1 GE-4 IOA
Number of IOA ports	■ 4
Software release	■ First supported: 7.0.1

Description	■ 30 W
	■ Half-height module
	■ See Slot Combinations on page 63 for more information on combining IOAs in a slot.
	■ Uses a range of small form-factor pluggable (SFP) transceivers to support different modes and cable lengths.
	■ Uses either optical or copper SFPs.
	  ■ The optical transceivers are 1000Base-SX, 1000Base-LX, and 1000Base-ZX compliant.
	  ■ The copper transceivers are 1000Base-T compliant.

Capability	■ Ethernet (IEEE 802.3x) ■ 1000Base-SX/LX/ZX
Software features	■ See Ethernet IOAs on page 45 for information about the layer 2 and layer 3 protocols and applications that this module combination supports.
Line module compatibility	■ ES2 4G LM
SRP module compatibility	■ SRP-100 ■ SRP-320
Line module redundancy compatibility	■ Can be paired with an ES2 4G LM. ■ Must be installed in the same redundancy group as an ES2 4G LM and ES2–S1 REDUND IOA combination.
Port redundancy support	■ Not applicable
Cables and connectors (copper SFP)	■ Maximum range is 100 meters on CAT5 cable.

Cables and connectors (multimode [SX])	■ Up to four LC-style fiber-optic connectors
	■ Transmit power:
	  ■ min: –9.5 dBm
	  ■ max: –4 dBm
	■ Receive input power:
	  ■ min: –20 dBm
	  ■ max: 0 dBm
	■ See the following corresponding table (SX Fiber Optic Cabling) for cabling requirements.
	■ See *E320 Hardware Guide, Chapter 5, Cabling the Router* for more information.

Cables and connectors (single-mode [LX])	■ Up to four LC-style fiber-optic connectors
	■ Transmit power:
	  ■ min: –9.5 dBm
	  ■ max: –3 dBm
	■ Receive input power:
	  ■ min: –20 dBm
	  ■ max: –3 dBm
	■ See the following corresponding table (LX Fiber Optic Cabling) for cabling requirements.
	■ See *E320 Hardware Guide, Chapter 5, Cabling the Router* for more information.

Cables and connectors (single-mode LX40)	■ Up to four LC-style fiber-optic connectors
	■ Transmit power:
	  ■ min: –4.5 dBm
	  ■ max: 0 dBm
	■ Receive input power:
	  ■ min: –35 dBm
	  ■ max: –22.5 dBm
	■ See the following corresponding table (LX40 Fiber Optic Cabling) for cabling requirements.
	■ See *E320 Hardware Guide, Chapter 5, Cabling the Router* for more information.

Cables and connectors (single-mode [ZX])	■ Up to four LC-style fiber-optic connectors
	■ Transmit power:
	  ■ min: –2 dBm
	  ■ max: 3 dBm
	■ Receive input power:
	  ■ min: –22 dBm
	  ■ max: –3 dBm
	■ See the following corresponding table (ZX Fiber Optic Cabling) for cabling requirements.
	■ See *E320 Hardware Guide, Chapter 5, Cabling the Router* for more information.

LEDs	When lit, LED indicates:
	■ OK (green)—Physical link is connected properly and is functioning properly
	■ FAIL (red)—Failure detected
	■ Port LEDs:
	  ■ LK (green)—Ethernet link is up
	  ■ ACT (green)—Blinks when there is Ethernet traffic being received

Alarms, errors, and events	■ See *Monitoring Ethernet Interfaces* in *JUNOSe Physical Layer Configuration Guide, Chapter 5, Configuring Ethernet Interfaces*.

Table 2: SX Fiber Optic Cabling

Fiber Type	Minimal Modal Bandwidth at 850 nm (MHz*km)	Maximum Operating Range (meters)
62.5 microns	160	220 (656.17 ft)
	200	275 (902.23 ft)
50 microns	400	500 (1640.42 ft)
	500	550 (1804.46 ft)

Table 3: LX Fiber Optic Cabling

Fiber Type	Nominal Wavelength (nm)	Maximum Operating Range (kilometers)
9 microns	1310	10 (6.2 miles)

Table 4: LX40 Fiber Optic Cabling

Fiber Type	Nominal Wavelength (nm)	Maximum Operating Range (kilometers)
9 microns	1310	40 (24.85 miles)

Table 5: ZX Fiber Optic Cabling

Fiber Type	Nominal Wavelength (nm)	Maximum Operating Range (kilometers)
10 microns	1550	70 (43.5 miles)

GE-8 IOA

IOA label	ES2–S1 GE-8 IOA
Number of IOA ports	■ 8
Software release	■ First supported: 7.2.0

Description	■ 21 W
	■ Gigabit Ethernet
	■ Half-height module
	■ See Slot Combinations on page 63 for more information on combining IOAs in a slot.
	■ Uses a range of small form-factor pluggable (SFP) transceivers to support different modes and cable lengths
	■ Uses either optical or copper SFPs.
	  ■ The optical transceivers are 1000Base-SX, 1000Base-LX, and 1000Base-ZX compliant.
	  ■ The copper transceivers are 1000Base-T compliant.

Capability	■ Ethernet (IEEE 802.3z) ■ 1000Base-SX/LX/ZX
Software features	■ See Ethernet IOAs on page 45 for information about the layer 2 and layer 3 protocols and applications that this module combination supports.
Line module compatibility	■ ES2 4G LM
SRP module compatibility	■ SRP-100 ■ SRP-320
Line module redundancy compatibility	■ Can be paired with an ES2 4G LM. ■ Must be installed in the same redundancy group as an ES2 4G LM and ES2–S1 REDUND IOA combination.
Port redundancy support	■ Not applicable
Cables and connectors (copper SFP)	■ Maximum range is 100 meters on CAT5 cable.

Cables and connectors (multimode [SX])	■ One LC full duplex connector
	■ Transmit power:
	  ■ min: –9.5 dBm
	  ■ max: –4 dBm
	■ Receive input power:
	  ■ min: –20 dBm
	  ■ max: 0 dBm
	■ See the following corresponding table (SX Fiber Optic Cabling) for cabling requirements.
	■ See *E320 Hardware Guide, Chapter 5, Cabling the Router* for more information.

Cables and connectors (single-mode [LX])	■ One LC full duplex connector
	■ Transmit power:
	  ■ min: –9.5 dBm
	  ■ max: –3 dBm
	■ Receive input power:
	  ■ min: –20 dBm
	  ■ max: –3 dBm
	■ See the following corresponding table (LX Fiber Optic Cabling) for cabling requirements.
	■ See *E320 Hardware Guide, Chapter 5, Cabling the Router* for more information.

Cables and connectors (single-mode LX40)	■ One LC full duplex connector
	■ Transmit power:
	  ■ min: –4.5 dBm
	  ■ max: 0 dBm
	■ Receive input power:
	  ■ min: –35 dBm
	  ■ max: –22.5 dBm
	■ See the following corresponding table (LX40 Fiber Optic Cabling) for cabling requirements.
	■ See *E320 Hardware Guide, Chapter 5, Cabling the Router* for more information.

Cables and connectors (single-mode [ZX])	■ One LC full duplex connector
	■ Transmit power:
	  ■ min: –2 dBm
	  ■ max: 3dBm
	■ Receive input power:
	  ■ min: –22 dBm
	  ■ max: –3 dBm
	■ See the following corresponding table (ZX Fiber Optic Cabling) for cabling requirements.
	■ See *E320 Hardware Guide, Chapter 5, Cabling the Router* for more information.

LEDs	Board-level LEDs: ■ OK (green)—IOA is online and is functioning properly ■ FAIL (red)—Failure detected Port LEDs: ■ LK (green)—Ethernet link is up ■ ACT (green)—Blinks when Ethernet traffic is being received
Alarms, errors, and events	■ See *Monitoring Ethernet Interfaces* in *JUNOSe Physical Layer Configuration Guide, Chapter 5, Configuring Ethernet Interfaces*.

Table 6: SX Fiber Optic Cabling

Fiber Type	Minimal Modal Bandwidth at 850 nm (MHz*km)	Maximum Operating Range (meters)
62.5 microns	160	220 (656.17 ft)
	200	275 (902.23 ft)
50 microns	400	500 (1640.42 ft)
	500	550 (1804.46 ft)

Table 7: LX Fiber Optic Cabling

Fiber Type	Nominal Wavelength (nm)	Maximum Operating Range (kilometers)
9 microns	1310	10 (6.2 miles)

Table 8: LX40 Fiber Optic Cabling

Fiber Type	Nominal Wavelength (nm)	Maximum Operating Range (kilometers)

Table 8: LX40 Fiber Optic Cabling *(continued)*

9 microns	1310	40 (24.85 miles)

Table 9: ZX Fiber Optic Cabling

Fiber Type	Nominal Wavelength (nm)	Maximum Operating Range (kilometers)
10 microns	1550	70 (43.5 miles)

10GE IOA

IOA label	ES2-S1 10GE IOA
Number of IOA ports	■ 1
Software release	■ First supported: 7.0.1
Description	■ 40 W ■ Full-height module ■ Uses a range of 10-gigabit small form-factor pluggable (XFP) transceivers to support different modes and cable lengths.
Capability	■ Ethernet (IEEE 802.3ae) ■ 10Gb Base-SR/LR/ER ■ Port can operate in full duplex mode with an average data rate of 3.4 Gbps
Software features	■ See Ethernet IOAs on page 45 for information about the layer 2 and layer 3 protocols and applications that this module combination supports.
Line module compatibility	■ ES2 4G LM
SRP module compatibility	■ SRP-100 ■ SRP-320
Line module redundancy compatibility	■ Can be paired with an ES2 4G LM. ■ Must be installed in the same redundancy group as an ES2 4G LM and ES2–S1 REDUND IOA combination.
Port redundancy support	■ Not applicable

Cables and connectors (multimode [SR])	■ One LC full duplex connector
	■ Transmit power:
	  ■ min: –7.3 dBm
	  ■ max: –1.0 dBm
	■ Receive input power:
	  ■ min: –9.9 dBm
	  ■ max: –1.0 dBm
	■ See the following corresponding table (SR Fiber Optic Cabling) for cabling requirements.
	■ See *E320 Hardware Guide, Chapter 5, Cabling the Router* for more information.

Cables and connectors (single-mode [LR])	■ One LC full duplex connector
	■ Transmit power:
	  ■ min: –8.2 dBm
	  ■ max: 0.5 dBm
	■ Receive input power:
	  ■ min: –14.4 dBm
	  ■ max: 0.5 dBm
	■ See the following corresponding table (LR Fiber Optic Cabling) for cabling requirements.
	■ See *E320 Hardware Guide, Chapter 5, Cabling the Router* for more information.

Cables and connectors (single-mode [ER])	■ One LC full duplex connector
	■ Transmit power:
	  ■ min: –4.7 dBm
	  ■ max: 4.0 dBm
	■ Receive input power:
	  ■ min: –15.8 dBm
	  ■ max: –1.0 dBm
	■ See the following corresponding table (ER Fiber Optic Cabling) for cabling requirements.
	■ See *E320 Hardware Guide, Chapter 5, Cabling the Router* for more information.

LEDs	Board-level LEDs: ■ OK (green)—Physical link is connected properly and is functioning properly ■ FAIL (red)—Failure detected Port LEDs: ■ LK (green)—Ethernet link is up ■ ACT (green)—Blinks when there is Ethernet traffic being received
Alarms, errors, and events	■ See *Monitoring Ethernet Interfaces* in *JUNOSe Physical Layer Configuration Guide, Chapter 5, Configuring Ethernet Interfaces*.

Table 10: SR Fiber Optic Cabling

Fiber Type	Minimal Modal Bandwidth at 850 nm (MHz*km)	Maximum Operating Range (meters)
62.5 microns	160	26 (85.3 ft)
	200	33 (108.27 ft)
50 microns	400	66 (216.54 ft)
	500	82 (269.03 ft)
	2000	300 (984.25 ft)

Table 11: LR Fiber Optic Cabling

Fiber Type	Nominal Wavelength (nm)	Maximum Operating Range (kilometers)
9 microns	1310	10 (6.2 miles)

Table 12: ER Fiber Optic Cabling

Fiber Type	Nominal Wavelength (nm)	Maximum Operating Range (kilometers)
9 microns	1550	40 (24.85 miles)

10GE PR IOA

IOA label	ES2-S2 10GE PR IOA
Number of IOA ports	■ 2 ■ 1 active, 1 redundant
Software release	■ First supported: 7.2.0
Description	■ 40 W ■ Full-height module ■ Uses a range of 10-gigabit small form-factor pluggable (XFP) transceivers to support different modes and cable lengths. ■ Pairs only with ES2 10G UPLINK LM and ES2 10G LM to provide 10-Gigabit Ethernet operation through a single line interface ■ Router can accommodate up to two ES2 10G UPLINK LM and ES2-S2 10GE PR IOA combinations
Capability	■ Ethernet (IEEE 802.3ae) ■ 10Gb Base-SR/LR/ER ■ Port can operate in full duplex mode with an average data rate of 10 Gbps
Software features	■ See Ethernet IOAs on page 45 for information about the layer 2 and layer 3 protocols and applications that this module combination supports.
Line module compatibility	■ ES2 10G UPLINK LM only
SRP module compatibility	■ SRP-100 ■ SRP-320
Line module redundancy compatibility	■ Not applicable
Port redundancy support	■ Yes

Cables and connectors (multimode [SR])	■ One LC full duplex connector
	■ Transmit power:
	  ■ min: –7.3 dBm
	  ■ max: –1.0 dBm
	■ Receive input power:
	  ■ min: –9.9 dBm
	  ■ max: –1.0 dBm
	■ See the following corresponding table (SR Fiber Optic Cabling) for cabling requirements.
	■ See *E320 Hardware Guide, Chapter 5, Cabling the Router* for more information.

Cables and connectors (single-mode [LR])	■ One LC full duplex connector
	■ Transmit power:
	  ■ min: –8.2 dBm
	  ■ max: 0.5 dBm
	■ Receive input power:
	  ■ min: –14.4 dBm
	  ■ max: 0.5 dBm
	■ See the following corresponding table (LR Fiber Optic Cabling) for cabling requirements.
	■ See *E320 Hardware Guide, Chapter 5, Cabling the Router* for more information.

Cables and connectors (single-mode [ER])	■ One LC full duplex connector
	■ Transmit power:
	  ■ min: –4.7 dBm
	  ■ max: 4.0 dBm
	■ Receive input power:
	  ■ min: –15.8 dBm
	  ■ max: –1.0 dBm
	■ See the following corresponding table (ER Fiber Optic Cabling) for cabling requirements.
	■ See *E320 Hardware Guide, Chapter 5, Cabling the Router* for more information.

LEDs	Board-level LEDs: ■ OK (green)—IOA online and is functioning properly ■ FAIL (red)—Failure detected Port LEDs: ■ LK (green)—Ethernet link is up ■ ACT (green)—Blinks when Ethernet traffic is being received Port labels: ■ W—Working port ■ P—Protect port (LK blinks when active cable is attached even though it is not the active working port)
Alarms, errors, and events	■ See *Monitoring Ethernet Interfaces* in *JUNOSe Physical Layer Configuration Guide, Chapter 5, Configuring Ethernet Interfaces*.

Table 13: SR Fiber Optic Cabling

Fiber Type	Minimal Modal Bandwidth at 850 nm (MHz*km)	Maximum Operating Range (meters)
62.5 microns	160	26 (85.3 ft)
	200	33 (108.27 ft)
50 microns	400	66 (216.54 ft)
	500	82 (269.03 ft)
	2000	300 (984.25 ft)

Table 14: LR Fiber Optic Cabling

Fiber Type	Nominal Wavelength (nm)	Maximum Operating Range (kilometers)
9 microns	1310	10 (6.2 miles)

Table 15: ER Fiber Optic Cabling

Fiber Type	Nominal Wavelength (nm)	Maximum Operating Range (kilometers)
9 microns	1550	40 (24.85 miles)

OC3/STM1-8 ATM IOA

IOA label	ES2-S1 OC3-8 STM1 ATM IOA
Number of IOA ports	■ 8
Software release	■ First supported: 7.0.1
Description	■ 50 W ■ Half-height module ■ See Slot Combinations on page 63 for more information on combining IOAs in a slot. ■ Uses a range of small form-factor pluggable (SFP) transceivers to support different modes and cable lengths.
Capability	■ OC3/STM1 ■ ATM
Software features	■ See OCx/STMx ATM IOAs on page 53 for information about the layer 2 and layer 3 protocols and applications that this module combination supports.
Line module compatibility	■ ES2 4G LM
SRP module compatibility	■ SRP-100 ■ SRP-320
Line module redundancy compatibility	■ Can be paired with an ES2 4G LM. ■ Must be installed in the same redundancy group as an ES2 4G LM and ES2–S1 REDUND IOA combination.
Port redundancy support	■ Not applicable

Cables and connectors (multimode)	■ Up to eight LC full duplex connectors
	■ Transmit power:
	  ■ min: –20 dBm
	  ■ max: –14 dBm
	■ Center wavelength: 1310 nm
	■ Receive input power:
	  ■ min: –30 dBm
	  ■ max: –14 dBm
	■ Rated for 2 km (1.2 miles) over 62.5-micron core cable with an optical loss of 0-9 dB or 50-micron core cable with an optical loss of 7 dB
	■ See *E320 Hardware Guide, Chapter 5, Cabling the Router* for more information.

Cables and connectors (single-mode intermediate [IR-1])	■ Up to eight LC full duplex connectors
	■ Transmit power:
	  ■ min: –15 dBm
	  ■ max: –8 dBm
	■ Center wavelength: 1310 nm
	■ Receive input power:
	  ■ min: –34 dBm
	  ■ max: –7 dBm
	■ Rated for 15 km (9.3 miles) of 9-micron core cable
	■ See *E320 Hardware Guide, Chapter 5, Cabling the Router* for more information.

Cables and connectors (single-mode long reach [LR-1])	■ Up to eight LC full duplex connectors
	■ Transmit power:
	  ■ min: –3 dBm
	  ■ max: 2 dBm
	■ Center wavelength: 1310 nm
	■ Receive input power:
	  ■ min: –28 dBm
	  ■ max: –7 dBm
	■ Rated for 40 km (24.9 miles) of 9-micron core cable
	■ See *E320 Hardware Guide, Chapter 5, Cabling the Router* for more information.

LEDs	Board-level LEDs:
	■ OK (green)—Physical link is connected properly and is functioning properly
	■ FAIL (red)—Failure detected
	
	Port LEDs:
	■ ALM—Bi-color LED:
	  ■ Yellow: Local loss of signal exists
	  ■ Red: Remote loss of signal exists
	■ OK (green)—SONET is up and port is functioning properly. If not lit, a problem exists.

Alarms, errors, and events	■ See *Monitoring SONET/SDH Interfaces* in *JUNOSe Physical Layer Configuration Guide, Chapter 3, Configuring Unchannelized OCx/STMx Interfaces*.

OC12/STM4-2 ATM IOA

IOA label	ES2-S1 OC12-2 STM4 ATM IOA
Number of IOA ports	■ 2
Software release	■ First supported: 7.0.1
Description	■ 40 W ■ Half-height module ■ See Slot Combinations on page 63 for more information on combining IOAs in a slot. ■ Uses a range of small form-factor pluggable (SFP) transceivers to support different modes and cable lengths.
Capability	■ OC12/STM4 ■ ATM
Software features	■ See OCx/STMx ATM IOAs on page 53 for information about the layer 2 and layer 3 protocols and applications that this module combination supports.
Line module compatibility	■ ES2 4G LM
SRP module compatibility	■ SRP-100 ■ SRP-320
Line module redundancy compatibility	■ Can be paired with an ES2 4G LM. ■ Must be installed in the same redundancy group as an ES2 4G LM and ES2–S1 REDUND IOA combination.
Port redundancy support	■ Not applicable

Cables and connectors (single-mode short reach [SR])	■ Up to two LC full duplex connectors
	■ Transmit power:
	  ■ min: –15 dBm
	  ■ max: –8 dBm
	■ Center wavelength: 1310 nm
	■ Receive input power:
	  ■ min: –28 dBm
	  ■ max: –7 dBm
	■ Rated for 2 km (1.24 miles) of 9-micron core cable
	■ See *E320 Hardware Guide, Chapter 5, Cabling the Router* for more information.

Cables and connectors (single-mode intermediate [IR-1])	■ Up to two LC full duplex connectors
	■ Transmit power:
	  ■ min: –15 dBm
	  ■ max: –8 dBm
	■ Center wavelength: 1310 nm
	■ Receive input power:
	  ■ min: –28 dBm
	  ■ max: –7 dBm
	■ Rated for 15 km (9.3 miles) of 9-micron core cable
	■ See *E320 Hardware Guide, Chapter 5, Cabling the Router* for more information.

Cables and connectors (single-mode long reach [LR-1])	■ Up to two LC full duplex connectors
	■ Transmit power:
	  ■ min: –3 dBm
	  ■ max: 2 dBm
	■ Center wavelength: 1310 nm
	■ Receive input power:
	  ■ min: –28 dBm
	  ■ max: –7 dBm
	■ Rated for 40 km (24.9 miles) of 9-micron core cable
	■ See *E320 Hardware Guide, Chapter 5, Cabling the Router* for more information.

LEDs	Board-level LEDs:
	■ OK (green)—Physical link is connected properly and is functioning properly
	■ FAIL (red)—Failure detected
	
	Port LEDs:
	■ ALM—Bi-color LED:
	  ■ Yellow: Local loss of signal exists
	  ■ Red: Remote loss of signal exists
	■ OK (green)—SONET is up and port is functioning properly. If not lit, a problem exists.

Alarms, errors, and events	■ See *Monitoring SONET/SDH Interfaces* in *JUNOSe Physical Layer Configuration Guide, Chapter 3, Configuring Unchannelized OCx/STMx Interfaces*.

OC12/STM4-2 POS IOA

IOA label	ES2-S1 OC12-2 STM4 POS IOA
Number of IOA ports	■ 2
Software release	■ First supported: 7.0.1
Description	■ 30 W ■ Half-height module ■ See Slot Combinations on page 63 for more information on combining IOAs in a slot. ■ Uses a range of small form-factor pluggable (SFP) transceivers to support different modes and cable lengths.
Capability	■ OC12/STM4 ■ POS
Software features	■ See OCx/STMx POS IOAs on page 56 for information about the layer 2 and layer 3 protocols and applications that this module combination supports.
Line module compatibility	■ ES2 4G LM
SRP module compatibility	■ SRP-100 ■ SRP-320
Module redundancy support	■ Yes (Redundancy IOA must be installed in either slot 0 or slot 11)
Line module redundancy compatibility	■ Can be paired with an ES2 4G LM. ■ Must be installed in the same redundancy group as an ES2 4G LM and ES2–S1 REDUND IOA combination.
Port redundancy support	■ Not applicable

Cables and connectors (single-mode short reach [SR])	■ Up to two LC full duplex connectors
	■ Transmit power:
	  ■ min: –15 dBm
	  ■ max: –8 dBm
	■ Center wavelength: 1310 nm
	■ Receive input power:
	  ■ min: –28 dBm
	  ■ max: –7 dBm
	■ Rated for 2 km (1.24 miles) of 9-micron core cable
	■ See *E320 Hardware Guide, Chapter 5, Cabling the Router* for more information.

Cables and connectors (single-mode intermediate [IR-1])	■ Up to two LC full duplex connectors
	■ Transmit power:
	  ■ min: –15 dBm
	  ■ max: –8 dBm
	■ Center wavelength: 1310 nm
	■ Receive input power:
	  ■ min: –28 dBm
	  ■ max: –7 dBm
	■ Rated for 15 km (9.3 miles) of 9-micron core cable
	■ See *E320 Hardware Guide, Chapter 5, Cabling the Router* for more information.

Cables and connectors (single-mode long reach [LR-1])	■ Up to two LC full duplex connectors
	■ Transmit power:
	  ■ min: –3 dBm
	  ■ max: 2 dBm
	■ Center wavelength: 1310 nm
	■ Receive input power:
	  ■ min: –28 dBm
	  ■ max: –7 dBm
	■ Rated for 40 km (24.9 miles) of 9-micron core cable
	■ See *E320 Hardware Guide, Chapter 5, Cabling the Router* for more information.

LEDs	Board-level LEDs:
	■ OK (green)—Physical link is connected properly and is functioning properly
	■ FAIL (red)—Failure detected
	
	Port LEDs:
	■ ALM—Bi-color LED:
	  ■ Yellow: Local loss of signal exists
	  ■ Red: Remote loss of signal exists
	■ OK (green)—SONET is up and port is functioning properly. If not lit, a problem exists.

Alarms, errors, and events	■ See *Monitoring SONET/SDH Interfaces* in *JUNOSe Physical Layer Configuration Guide, Chapter 3, Configuring Unchannelized OCx/STMx Interfaces*.

OC48/STM16 POS IOA

IOA label	ES2-S1 OC48 STM16 POS IOA
Number of IOA ports	■ 1
Software release	■ First supported: 7.0.1
Description	■ 30 W ■ Half-height module ■ See Slot Combinations on page 63 for more information on combining IOAs in a slot. ■ Unchannelized, concatenated OC48/STM16 for POS
Capability	■ OC48/STM16 ■ HDLC framing
Software features	■ See OCx/STMx POS IOAs on page 56 for information about the layer 2 and layer 3 protocols and applications that this module combination supports.
Line module compatibility	■ ES2 4G LM
SRP module compatibility	■ SRP-100 ■ SRP-320
Line module redundancy compatibility	■ Can be paired with an ES2 4G LM. ■ Must be installed in the same redundancy group as an ES2 4G LM and ES2–S1 REDUND IOA combination.
Module redundancy support	■ Yes (Redundancy IOA must be installed in either slot 0 or slot 11)
Port redundancy support	■ Not applicable

Cables and connectors (single-mode short reach [SR-1])	■ Up to one LC full duplex connector
	■ Transmit power:
	  ■ min: –10 dBm
	  ■ max: –3 dBm
	■ Center wavelength: 1310 nm
	■ Receive input power:
	  ■ min: –18 dBm
	  ■ max: –3 dBm
	■ Rated for 2 km (1.2 miles) of 9-micron core cable
	■ See *E320 Hardware Guide, Chapter 5, Cabling the Router* for more information.

Cables and connectors (single-mode intermediate [IR-1])	■ Up to one LC full duplex connector
	■ Transmit power:
	  ■ min: –5 dBm
	  ■ max: 0 dBm
	■ Center wavelength: 1266 through 1310 nm
	■ Receive input power:
	  ■ min: –18 dBm
	  ■ max: –0 dBm
	■ Rated for 15 km (9.3 miles) of 9-micron core cable
	■ See *E320 Hardware Guide, Chapter 5, Cabling the Router* for more information.

Cables and connectors (single-mode long reach [LR-2])	■ Up to one LC full duplex connector
	■ Transmit power:
	  ■ min: –2 dBm
	  ■ max: 3 dBm
	■ Center wavelength: 1550 through 1580 nm
	■ Receive input power:
	  ■ min: –28 dBm
	  ■ max: –9 dBm
	■ Rated for 80 km (24.9 miles) of 9-micron core cable
	■ See *E320 Hardware Guide, Chapter 5, Cabling the Router* for more information.

LEDs	Board-level LEDs:
	■ OK (green)—Physical link is connected properly and is functioning properly
	■ FAIL (red)—Failure detected
	
	Port LEDs:
	■ ALM—Bi-color LED:
	  ■ Yellow: Local loss of signal exists
	  ■ Red: Remote loss of signal exists
	■ OK (green)—SONET is up and port is functioning properly. If not lit, a problem exists.

Alarms, errors, and events	■ See *Monitoring SONET/SDH Interfaces* in *JUNOSe Physical Layer Configuration Guide, Chapter 3, Configuring Unchannelized OCx/STMx Interfaces*.

Redundancy IOA

IOA label	ES2-S1 REDUND IOA
Number of IOA ports	■ 0
Software release	■ First supported: 7.0.1
Description	■ 10 W ■ Full-height module ■ Provides redundancy for line modules ■ Inserted in slot 0 and 11 only
Capability	■ Provides switchover when a line module fails ■ Provides N + 1 redundancy for line modules ■ When inserted in slot 0, provides redundancy for a failed line module in slots 1–5. When inserted in slot 11, provides redundancy for a failed line module in slots 12–16.
Software features	■ See *JUNOSe System Basics Configuration Guide, Chapter 6, Managing Modules*.
Line module compatibility	■ ES2 4G LM ■ ES2 10G UPLINK LM ■ ES2 10G LM
SRP module compatibility	■ SRP-100 ■ SRP-320
Line module redundancy compatibility	■ Not applicable
Port redundancy support	■ Not applicable
Cables and connectors	■ Not applicable
LEDs	■ OK (green)—Self-test passed ■ FAIL (red)—Failure detected
Alarms, errors, and events	■ See *Monitoring Modules* in *JUNOSe System Basics Configuration Guide, Chapter 6, Managing Modules*.

Service IOA

IOA label	ES2-S1 SERVICE IOA
Number of IOA ports	■ 0
Software release	■ First supported: 7.0.1
Description	■ 10 W ■ Full-height module ■ Provides tunnel server functionality ■ Pairs with associated line module to receive data from and transmit data to other line modules with ingress and egress ports

Capability	■ Tunnelling
	■ Provides support for:
	  ■ Distance Vector Multicast Routing Protocol (DVMRP) tunnels, also known as IP-in-IP tunnels
	  ■ Generic Routing Protocol (GRE) tunnels
	  ■ IP packet reassembly for tunnels
	  ■ MPLS tunnels

Software features	■ See Service IOA on page 59 for information about the layer 2 and layer 3 protocols and applications that this module combination supports.
Line module compatibility	■ ES2 4G LM
SRP module compatibility	■ SRP-100 ■ SRP-320
Module redundancy support	■ Not applicable
Port redundancy support	■ Not applicable
Cables and connectors	■ Not applicable
LEDs	■ OK (green)—Self-test passed ■ FAIL (red)—Failure detected ■ ONLINE (green)—Online with no alarms or errors
Alarms, errors, and events	■ See *Monitoring Tunnel-Service Interfaces* in *JUNOSe Physical Layer Configuration Guide, Chapter 6, Managing Tunnel-Service and IPSec-Service Interfaces*.

SRP IOA

Module label	SRP IOA
IOA label	■ Not applicable
Number of IOA ports	■ 3
Software release	■ First supported: 7.0.1
Description	■ 10 W ■ Pairs with SRP module ■ Interfaces with the SRP modules through the system's midplane.
Capability	■ Ethernet (IEEE 802.3) ■ 10/100Base-T ■ RS-232 ■ Auxiliary port allows access to debug ports on a specific processor (SRP module, LM)
Software features	■ Not applicable
Line module compatibility	■ Not applicable
SRP module compatibility	■ SRP-100 ■ SRP-320
Port redundancy support	■ Not applicable
Cables and connectors	■ Terminal blocks ■ Two dual-purpose BNC connectors (primary and secondary) for BITS timing clock sources (E1 or T1); 75–ohm E1 2.048–Mbps/T1 1.544–Mbps inputs terminating with a 120/75 ohm or 100/75 ohm balun ■ One 10/100Base-T Ethernet management port with an RJ-45 connector ■ Two RS-232 ports with DB-9 connectors for direct command line interface (CLI) and debug access ■ See *E320 Hardware Guide, Chapter 5, Cabling the Router* for more information.
LEDs	■ None
Alarms, errors, and events	■ See *Monitoring Modules* in *JUNOSe System Basics Configuration Guide, Chapter 6, Managing Modules*.

Appendix A

IOA Protocol Support

This appendix lists the layer 2 and layer 3 protocols and applications that IOAs support in combination with the listed LM. IOAs are identified by their physical labels. See Table 1 on page 3 for a list of IOAs and their identifying labels.

The designation “not yet fully qualified” that appears in some tables in this appendix indicates that support for the protocol or application on the specified IOA has not yet been fully qualified by Juniper Networks. If you use a feature before it has been fully qualified, it is your responsibility to ensure that it operates correctly in your targeted configuration.

This appendix contains the following sections:

- Ethernet IOAs on page 45
- OCx/STMx ATM IOAs on page 53
- OCx/STMx POS IOAs on page 56
- Service IOA on page 59

Ethernet IOAs

Table 16: Ethernet IOAs with ES2 4G LM

Protocol or Application	ES2–S1 GE-4 IOA (with ES2 4G LM)	ES2–S1 GE-8 IOA (with ES2 4G LM)	ES2–S1 10GE IOA (with ES2 4G LM)
Accepts traffic destined for GRE tunnels or DVMRP (IP-in-IP) tunnels	Yes	Yes	Yes
APS/MSP	No	No	No
ATM	No	No	No
BERT	No	No	No
BGP	Yes	Yes	Yes
BGP/MPLS VPNs	Yes	Yes	Yes
Bridged Ethernet	No	No	No

Table 16: Ethernet IOAs with ES2 4G LM *(continued)*

Protocol or Application	ES2–S1 GE-4 IOA (with ES2 4G LM)	ES2–S1 GE-8 IOA (with ES2 4G LM)	ES2–S1 10GE IOA (with ES2 4G LM)
Bridged IP	No	No	No
CBF	No	No	No
Cisco HDLC	No	No	No
DHCP external server	Yes	Yes	Yes
DHCP local server	Yes	Yes	Yes
DVMRP and GRE support—access side	Yes	Yes	Yes
DVMRP and GRE support—server side	Yes (over shared tunnel server ports)	Yes (over shared tunnel server ports)	Yes (over shared tunnel server ports)
Dynamic interfaces	Yes	Yes	Yes
F4 OAM and F5 OAM (ATM administration)	No	No	No
FDL (facilities data link)	No	No	No
Firewall	No	No	No
Frame Relay	No	No	No
IEEE 802.3ad link aggregation	Yes	Yes	No
IP	Yes	Yes	Yes
IP multicast	Yes	Yes	Yes
IP reassembly for tunneled packets	Yes	Yes	Yes
IPSec	No	No	No
IPv6	Yes	Yes	Yes
IPv6 multicast	Yes	Yes	Yes
IPv6 neighbor discovery	Yes	Yes	Yes
IS-IS	Yes	Yes	Yes
J-Flow Statistics	Yes	Yes	Yes
L2TP/IPSec	No	No	No
LAC support—access side	Yes	Yes	Yes
LAC support—peer side	Yes	Yes	Yes

Table 16: Ethernet IOAs with ES2 4G LM *(continued)*

Protocol or Application	ES2–S1 GE-4 IOA (with ES2 4G LM)	ES2–S1 GE-8 IOA (with ES2 4G LM)	ES2–S1 10GE IOA (with ES2 4G LM)
LNS support—peer side	Yes	Yes	Yes
Local loopback	No	No	No
MDL (maintenance data link)	No	No	No
MPLS	Yes	Yes	Yes
Multilink Frame Relay	No	No	No
Multilink PPP	No	No	No
Network Address Translation (NAT)	No	No	No
NBMA (multipoint ATM)	No	No	No
OSPF	Yes	Yes	Yes
Packet Mirroring	Yes	Yes	Yes
Packet over SONET	No	No	No
PPP	No	No	No
PPPoE	Yes	Yes	Yes
Remote loopback	No	No	No
RIP	Yes	Yes	Yes
Subscriber interfaces (static)	Yes	Yes	Yes
Subscriber interfaces (dynamic)	Yes	Yes	Yes
Transparent bridging	Yes	Yes	Yes
Tunnel-server ports	Yes (shared only)	Yes (shared only)	Yes (shared only)
VPLS (network interfaces)	Yes	Yes	Yes
VPLS (virtual core interfaces)	Yes	Yes	Yes
VRRP	Yes	Yes	Yes

Table 17: Ethernet IOAs with ES2 10G Uplink LM

Protocol or Application	ES2–S2 10GE PR IOA (with ES2 10G Uplink LM)
Accepts traffic destined for GRE tunnels or DVMRP (IP-in-IP) tunnels	Yes
APS/MSP	No
ATM	No
BERT	No
BGP	Yes
BGP/MPLS VPNs	No
Bridged Ethernet	No
Bridged IP	No
CBF	No
Cisco HDLC	No
DHCP external server	Yes
DHCP local server	Yes
DVMRP and GRE support—access side	Yes
DVMRP and GRE support—server side	No
Dynamic interfaces	No
F4 OAM and F5 OAM (ATM administration)	No
FDL (facilities data link)	No
Firewall	No
Frame Relay	No
IEEE 802.3ad link aggregation	No
IP	Yes
IP multicast	Yes
IP reassembly for tunneled packets	No
IPSec	No
IPv6	Yes
IPv6 multicast	Yes
IPv6 neighbor discovery	Yes

Table 17: Ethernet IOAs with ES2 10G Uplink LM *(continued)*

Protocol or Application	ES2–S2 10GE PR IOA (with ES2 10G Uplink LM)
IS-IS	Yes
J-Flow Statistics	No
L2TP/IPSec	No
LAC support—access side	No
LAC support—peer side	Yes
LNS support—peer side	Yes
Local loopback	No
MDL (maintenance data link)	No
MPLS	Yes (LER only)
Multilink Frame Relay	No
Multilink PPP	No
Network Address Translation (NAT)	No
NBMA (multipoint ATM)	No
OSPF	Yes
Packet Mirroring	No
Packet over SONET	No
PPP	No
PPPoE	No
Remote loopback	No
RIP	Yes
Subscriber interfaces (static)	No
Subscriber interfaces (dynamic)	No
Transparent bridging	No
Tunnel-server ports	No
VPLS (network interfaces)	No
VPLS (virtual core interfaces)	No
VRRP	No

Table 18: Ethernet IOAs with ES2 10G LM

Protocol or Application	ES2–S1 GE-8 IOA (with ES2 10G LM)	ES2–S2 10GE PR IOA (with ES2 10G LM)
Accepts traffic destined for GRE tunnels or DVMRP (IP-in-IP) tunnels	Yes	Yes
APS/MSP	No	No
ATM	No	No
BERT	No	No
BGP	Yes	Yes
BGP/MPLS VPNs	No	No
Bridged Ethernet	No	No
Bridged IP	No	No
CBF	No	No
Cisco HDLC	No	No
DHCP external server	Yes	Yes
DHCP local server	Yes	Yes
DVMRP and GRE support—access side	Yes	Yes
DVMRP and GRE support—server side	No	No
Dynamic interfaces	Yes (except dynamic VLAN subinterfaces based on agent-circuit-identifier information)	Yes (except dynamic VLAN subinterfaces based on agent-circuit-identifier information)
F4 OAM and F5 OAM (ATM administration)	No	No
FDL (facilities data link)	No	No
Firewall	No	No
Frame Relay	No	No
IEEE 802.3ad link aggregation	No	No
IP	Yes	Yes
IP multicast	Yes	Yes
IP reassembly for tunneled packets	No	No
IPSec	No	No
IPv6	Yes	Yes

Table 18: Ethernet IOAs with ES2 10G LM *(continued)*

Protocol or Application	ES2–S1 GE-8 IOA (with ES2 10G LM)	ES2–S2 10GE PR IOA (with ES2 10G LM)
IPv6 multicast	Yes	Yes
IPv6 neighbor discovery	Yes	Yes
IS-IS	Yes	Yes
J-Flow Statistics	No	No
L2TP/IPSec	No	No
LAC support—access side	Yes	Yes
LAC support—peer side	Yes	Yes
LNS support—peer side	Yes	Yes
Local loopback	No	No
MDL (maintenance data link)	No	No
MPLS	Yes (LER only)	Yes (LER only)
Multilink Frame Relay	No	No
Multilink PPP	No	No
Network Address Translation (NAT)	No	No
NBMA (multipoint ATM)	No	No
OSPF	Yes	Yes
Packet Mirroring	No	No
Packet over SONET	No	No
PPP	Yes	Yes
PPPoE	Yes	Yes
Remote loopback	No	No
RIP	Yes	Yes
Subscriber interfaces (static)	Yes	Yes
Subscriber interfaces (dynamic)	Yes	Yes
Transparent bridging	No	No
Tunnel-server ports	No	No
VPLS (network interfaces)	No	No

Table 18: Ethernet IOAs with ES2 10G LM *(continued)*

Protocol or Application	ES2–S1 GE-8 IOA (with ES2 10G LM)	ES2–S2 10GE PR IOA (with ES2 10G LM)
VPLS (virtual core interfaces)	No	No
VRRP	No	No

OCx/STMx ATM IOAs

Table 19: OCx/STMx ATM IOA

Protocol or Application	ES2–S1 OC3–8 STM1 ATM IOA	ES2–S1 OC12–2 STM4 ATM IOA
Accepts traffic destined for GRE tunnels or DVMRP (IP-in-IP) tunnels	Yes	Yes
APS/MSP	No	No
ATM	Yes	Yes
BERT	No	No
BGP	Yes	Yes
BGP/MPLS VPNs	Yes	Yes
Bridged Ethernet	Yes	Yes
Bridged IP	Yes	Yes
CBF	No	No
Cisco HDLC	No	No
DHCP external server	Yes	Yes
DHCP local server	Yes	Yes
DVMRP and GRE support—access side	Yes	Yes
DVMRP and GRE support—server side	Yes (over shared tunnel server ports)	Yes (over shared tunnel server ports)
Dynamic interfaces	Yes	Yes
F4 OAM and F5 OAM (ATM administration)	Yes	Yes
FDL (facilities data link)	No	No
Firewall	No	No
Frame Relay	No	No
IEEE 802.3ad link aggregation	No	No
IP	Yes	Yes
IP multicast	Yes	Yes
IP reassembly for tunneled packets	Yes	Yes
IPSec	No	No
IPv6	Yes	Yes

Table 19: OCx/STMx ATM IOA *(continued)*

Protocol or Application	ES2–S1 OC3–8 STM1 ATM IOA	ES2–S1 OC12–2 STM4 ATM IOA
IPv6 multicast	Yes	Yes
IPv6 neighbor discovery	Yes	Yes
IS-IS	Yes	Yes
J-Flow Statistics	Yes	Yes
L2TP/IPSec	No	No
LAC support—access side	Yes	Yes
LAC support—peer side	Yes	Yes
LNS support—peer side	Yes	Yes
Local loopback	No	No
MDL (maintenance data link)	No	No
MPLS	Yes	Yes
Multilink Frame Relay	No	No
Multilink PPP	No	No
Network Address Translation (NAT)	No	No
NBMA (multipoint ATM)	No	No
OSPF	Yes	Yes
Packet Mirroring	No	No
Packet over SONET	No	No
PPP	Yes	Yes
PPPoE	Yes	Yes
Remote loopback	No	No
RIP	Yes	Yes
Subscriber interfaces (static)	Yes	Yes
Subscriber interfaces (dynamic)	Yes	Yes
Transparent bridging	Yes	Yes
Tunnel-server ports	Yes (shared only)	Yes (shared only)
VPLS (network interfaces)	Yes	Yes

Table 19: OCx/STMx ATM IOA *(continued)*

Protocol or Application	ES2–S1 OC3–8 STM1 ATM IOA	ES2–S1 OC12–2 STM4 ATM IOA
VPLS (virtual core interfaces)	Yes	Yes
VRRP	No	No

OCx/STMx POS IOAs

Table 20: OCx/STMx POS IOA

Protocol or Application	ES2–S1 OC48 STM16 POS IOA	ES2–S1 OC12–2 STM4 POS IOA
Accepts traffic destined for GRE tunnels or DVMRP (IP-in-IP) tunnels	Yes	Yes
APS/MSP	No	No
ATM	No	No
BERT	No	No
BGP	Yes	Yes
BGP/MPLS VPNs	Yes	Yes
Bridged Ethernet	No	No
Bridged IP	No	No
CBF	No	No
Cisco HDLC	Yes	Yes
DHCP external server	No	No
DHCP local server	No	No
DVMRP and GRE support—access side	Yes	Yes
DVMRP and GRE support—server side	Yes	Yes (over shared tunnel server ports)
Dynamic interfaces	No	No
F4 OAM and F5 OAM (ATM administration)	No	No
FDL (facilities data link)	No	No
Firewall	No	No
Frame Relay	No	No
IEEE 802.3ad link aggregation	No	No
IP	Yes	Yes
IP multicast	Yes	Yes
IP reassembly for tunneled packets	Yes	Yes
IPSec	No	No
IPv6	Yes	Yes

Table 20: OCx/STMx POS IOA *(continued)*

Protocol or Application	ES2–S1 OC48 STM16 POS IOA	ES2–S1 OC12–2 STM4 POS IOA
IPv6 multicast	Yes	Yes
IPv6 neighbor discovery	No	No
IS-IS	Yes	Yes
J-Flow Statistics	Yes	Yes
L2TP/IPSec	No	No
LAC support—access side	No	No
LAC support—peer side	Yes	Yes
LNS support—peer side	Yes	Yes
Local loopback	No	No
MDL (maintenance data link)	No	No
MPLS	Yes	Yes
Multilink Frame Relay	No	No
Multilink PPP	No	No
Network Address Translation (NAT)	No	No
NBMA (multipoint ATM)	No	No
OSPF	Yes	Yes
Packet Mirroring	No	No
Packet over SONET	Yes	Yes
PPP	Yes	Yes
PPPoE	No	No
Remote loopback	No	No
RIP	Yes	Yes
Subscriber interfaces (static)	Yes	Yes
Subscriber interfaces (dynamic)	No	No
Transparent bridging	No	No
Tunnel-server ports	Yes (shared only)	Yes (shared only)
VPLS (network interfaces)	No	No

Table 20: OCx/STMx POS IOA *(continued)*

Protocol or Application	ES2–S1 OC48 STM16 POS IOA	ES2–S1 OC12–2 STM4 POS IOA
VPLS (virtual core interfaces)	Yes	Yes
VRRP	No	No

Service IOA

Table 21: Service IOA

Protocol or Application	ES2–S1 SERVICE IOA
Accepts traffic destined for GRE tunnels or DVMRP (IP-in-IP) tunnels	No
APS/MSP	No
ATM	No
BERT	No
BGP	Yes
BGP/MPLS VPNs	Yes
Bridged Ethernet	No
Bridged IP	No
CBF	No
Cisco HDLC	No
DHCP external server	No
DHCP local server	No
DVMRP and GRE support—access side	No
DVMRP and GRE support—server side	Yes (over dedicated tunnel server ports)
Dynamic interfaces	No
F4 OAM and F5 OAM (ATM administration)	No
FDL (facilities data link)	No
Firewall	No
Frame Relay	No
IEEE 802.3ad link aggregation	No
IP	Yes
IP multicast	No
IP reassembly for tunneled packets	Yes
IPSec	No
IPv6	No
IPv6 multicast	Yes

Table 21: Service IOA *(continued)*

Protocol or Application	ES2–S1 SERVICE IOA
IPv6 neighbor discovery	No
IS-IS	Yes
J-Flow Statistics	Yes
L2TP/IPSec	No
LAC support—access side	No
LAC support—peer side	No
LNS support—peer side	Yes
Local loopback	No
MDL (maintenance data link)	No
MPLS	Yes
Multilink Frame Relay	No
Multilink PPP	Yes (with fragmentation and reassembly; dynamic only)
Network Address Translation (NAT)	No
NBMA (multipoint ATM)	No
OSPF	Yes
Packet Mirroring	No
Packet over SONET	No
PPP	No
PPPoE	No
Remote loopback	No
RIP	Yes
Subscriber interfaces (static)	Yes (over GRE tunnels only)
Subscriber interfaces (dynamic)	Yes (over GRE tunnels only)
Transparent bridging	No
Tunnel-server ports	Yes (dedicated only)
VPLS (network interfaces)	No
VPLS (virtual core interfaces)	Yes

Table 21: Service IOA *(continued)*

Protocol or Application	ES2–S1 SERVICE IOA
VRRP	No

Appendix B
Slot Combinations

This appendix lists the IOA slot combinations and contains the following sections:

- IOA Slot Combinations on page 63

IOA Slot Combinations

Depending on the software release and IOA type, you must install IOAs in certain slots and bays combined with other IOAs in the same slot:

- You must insert some IOAs only in the upper bay (Adapter 0) of each IOA module slot. If you insert one of these IOAs into a lower bay slot, the line module diagnostics fail, an error message states that the bottom slot is not supported for the currently installed software release, and the slot is disabled.
- If you insert an unrecognized IOA, such as an IOA that is not supported by a particular software release, the line module diagnostics fail, an error is generated, and the slot is disabled.
- If you remove an IOA and replace it with a different IOA in the same slot, an error message states the mismatch and the slot is disabled.
- Full-height IOAs take up the entire slot (both Adapter 0 and Adapter 1).

For information about working with modules and IOAs, see *JUNOSe System Basics Configuration Guide, Chapter 6, Managing Modules*. See Table 22 on page 63 for currently available IOAs and the bays in which you may insert them.

Table 22: E320 IOA Locations and Combinations

IOA	Upper Bay (Adapter 0)	Lower Bay (Adapter 1)	Both Bays Concurrently	Combined with Other IOAs in Same Slot
ES2-S1 GE-4	Yes	Yes	No	No
ES2-S1 GE-8	Yes	Yes	Yes	Yes (GE-8 when paired with ES2 4G LM or ES2 10G LM; GE-8, OC3/STM1, and OC12/STM4 IOAs when paired with ES2 4G LM)

Table 22: E320 IOA Locations and Combinations *(continued)*

IOA	Upper Bay (Adapter 0)	Lower Bay (Adapter 1)	Both Bays Concurrently	Combined with Other IOAs in Same Slot
ES2-S1 10GE	Yes (Full-height IOA)	Not applicable	Not applicable	Not applicable
ES2-S2 10GE PR	Yes (Full-height IOA)	Not applicable	Not applicable	Not applicable
ES2-S1 OC3-8 STM1 ATM	Yes	Yes	Yes	Yes (GE-8, OC3/STM1, and OC12/STM4 IOAs only)
ES2-S1 OC12-2 STM4 ATM	Yes	Yes	Yes	Yes (GE-8, OC3/STM1, and OC12/STM4 IOAs only)
ES2-S1 OC12-2 STM4 POS	Yes	Yes	Yes	Yes (GE-8, OC3/STM1, and OC12/STM4 IOAs only)
ES2-S1 OC48 STM16 POS	Yes	Yes	No	No
ES2-S1 SERVICE	Yes (Full-height IOA)	Not applicable	Not applicable	Not applicable
ES2-S1 REDUND	Yes (Full-height IOA; slots 0 and 11 only)	Not applicable	Not applicable	Not applicable

Appendix C

Module Name Cross-Reference Information

■ Module Name Cross-Reference Information on page 65

Module Name Cross-Reference Information

Use Table 23 on page 65 to find the label name, software display name, and model number of a module.

Table 23: Module Naming Reference

Label Name	Software Display Name	Model Number
SRP Modules		
SRP IOA	SRP-IOA	ES2-SRP-IOA
SRP-100	SRP-100	ES2-100G-SRP
SRP-320	SRP-320	ES2-320G-SRP
SFM Modules		
SFM-100	SFM-100	ES2-100G-SFM
SFM-320	SFM-320	ES2-320G-SFM
Line Modules		
ES2 4G LM	LM-4	ES2-4GS1-MOD
ES2 10G UPLINK LM	LM-10 Uplink	ES2-10GUPS2-MOD
ES2 10G LM	LM-10	ES2-10GACS3-MOD
IOAs		
ES2-S1 GE-4 IOA	GE-4 IOA	ES2-GE4S1-IOA
ES2-S1 GE-8 IOA	GE-8 IOA	ES2-GE8S1-IOA
ES2-S1 10GE IOA	10GE IOA	ES2-10GES1-IOA
ES2-S2 10GE PR IOA	10GE PR IOA	ES2-10GES2-IOA

Table 23: Module Naming Reference *(continued)*

Label Name	Software Display Name	Model Number
ES2-S1 OC3-8 STM1 ATM IOA	OC3/STM1-8 ATM IOA	ES2-8OC3AS1-IOA
ES2-S1 OC12-2 STM4 ATM IOA	OC12/STM4-2 ATM IOA	ES2-2OC12AS1-IOA
ES2-S1 OC12-2 STM4 POS IOA	OC12/STM4-2 POS IOA	ES2-2OC12PS1-IOA
ES2-S1 OC48 STM16 POS IOA	OC48/STM16 POS IOA	ES2-OC48PS1-IOA
ES2-S1 REDUND IOA	REDUNDANCY IOA	ES2-REDUNDS1-IOA
ES2-S1 SERVICE IOA	SERVICE IOA	ES2-SERVS1-IOA

Appendix D

Product Reclamation and Recycling Program

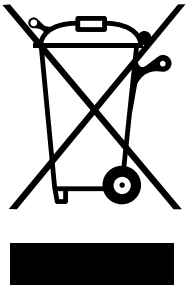
■ Product Reclamation and Recycling Program on page 67

Product Reclamation and Recycling Program

Juniper Networks is committed to environmentally responsible behavior. As part of this commitment, we continually work to comply with environmental standards such as the European Union's *Waste Electrical and Electronic Equipment* (WEEE) Directive and *Restriction of Hazardous Substances* (RoHS) Directive.

These directives and other similar regulations from countries outside the European Union regulate electronic waste management and the reduction or elimination of specific hazardous materials in electronic products. The WEEE Directive requires electrical and electronics manufacturers to provide mechanisms for the recycling and reuse of their products. The RoHS Directive restricts the use of certain substances that are commonly found in electronic products today. Restricted substances include heavy metals, including lead, and polybrominated materials. The RoHS Directive, with some exemptions, applies to all electrical and electronic equipment.

In accordance with Article 11(2) of Directive 2002/96/EC (WEEE), products put on the market after 13 August 2005 are marked with the following symbol or include it in their documentation: a crossed-out wheeled waste bin with a bar beneath.



Juniper Networks provides recycling support for our equipment worldwide to comply with the WEEE Directive. For recycling information, go to http://www.juniper.net/environmental, and indicate the type of Juniper Networks equipment that you wish to dispose of and the country where it is currently located, or contact your Juniper Networks account representative.

Products returned through our reclamation process are recycled, recovered, or disposed of in a responsible manner. Our packaging is designed to be recycled and should be handled in accordance with your local recycling policies.

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